Distribution of Time by Electricity—Chronographs.

To those acquainted with the difficulties in the way of communicating a uniform impulse to the pendulum through the medium of a train of wheel-work, it has, always been a favourite idea directly to maintain the swing of the pendulum by means of an electric current, but, unfortunately, the thing has not hitherto proved feasible; apparently it must be taken for granted that the action of an electric current cannot be *constantly* maintained.

But although electricity is of little service for keeping clocks going, it has been very successfully employed in controlling them. It is, of course, very much more economical to have inferior clocks than good ones, and what is done in this case is to use one good clock for the purpose of controlling a quantity of bad ones. The nature of the apparatus is in general this: our first good clock and all the others are placed in the circuit of a galvanic battery, and what our first good clock does is to close the circuit and transmit a current at every beat of its pendulum. The passage of an electric current around a coil of copper wire (as you no doubt know) converts it for so long as it passes into a magnet, and this current so transmitted by the clock is employed for such a purpose, and the magnets so formed are constructed to operate upon the pendulums of the controlled clocks and accelerate them if they are

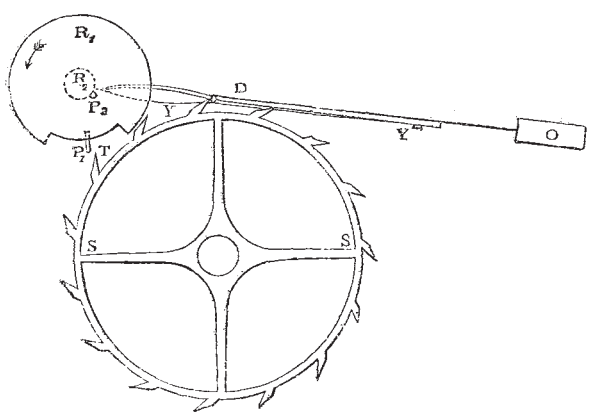


FIG 22.

lagging, or resist them if they should be moving too quickly.

Electricity is also employed for the purpose of correcting the time of a clock, say once a day. In this case the clock which is to be corrected is kept at a slight gaining rate. Upon the axis of its escape-wheel is a little finger which revolves with it. At a few seconds before, say 1 o'clock, the controlling clock, by the transmission of a current, brings down an arm in front of the finger and stops the controlled clock for just so many seconds as it is in advance of the controlling clock; at 1 o'clock the arm is raised again, and the controlled and controlling clock start off approximately together.

Such a controlling clock as is used to transmit a current, say once a day, is also employed for the purpose of dropping time-balls and discharging guns. The time-ball itself is generally composed of wicker-work covered with canvas, and is wound up by hand to its position a few minutes before the transmission of the current, and held by a hook or detent. Upon the arrival of the current the detent (by what arrangement it is unnecessary to describe) is withdrawn, and the time-ball falls.

To discharge a time-gun, the current usually passes through a very fine platinum wire, which it makes red-hot. Both with time-balls and guns, and wherever it has heavy work to perform, the current from the clock is employed to close another and much more powerful circuit, the latter being that which operates upon the mechanism.

Instruments employed for the purpose of registering the passage of short intervals of time are called chronographs. These in the main consist of a cylinder covered around with paper revolving at a uniform rate. The rotation of those employed in observatories is generally controlled by what is called a conical pendulum, that is, a pendulum swinging round in the surface of a cone. Such pendulums are much more sensitive to any slight change in the pressure of the clock-train than ordinary oscillating pendulums, and require to be controlled by special apparatus. The pendulum used at Greenwich is so contrived, that when it endeavours to move faster (in doing so, of course swinging out further) it dips little spades into an annular trough of glycerine, and its velocity by this means is checked.

The operation of the apparatus is the following:—A pin upon the pendulum of the normal sidereal clock presses two weak springs together at every vibration, and so transmits a current. This current, by making an electro-magnet, brings down a striker upon the paper of the revolving cylinder. By an arrangement similar to a screw-cutting lathe, the frame carrying this striker just as the cylinder rotates, travels alongside of it, and the clock-beats are consequently indicated upon the cylinder in the form of a spiral of successive pricks. The mechanism attached to the clock is arranged so as to pass no current at the termination of each minute (the sixtieth second), and consequently a blank is left upon the cylinder, by which anybody can tell when the minute happened. Upon the same frame alongside the first striker is a second, which can be brought down by the observer at any one of the instruments, by touching a button at his side. His observation is consequently registered upon the barrel alongside the clock-beat, and you have no difficulty in determining its precise time of occurrence to the tenth or one-hundredth of a second.

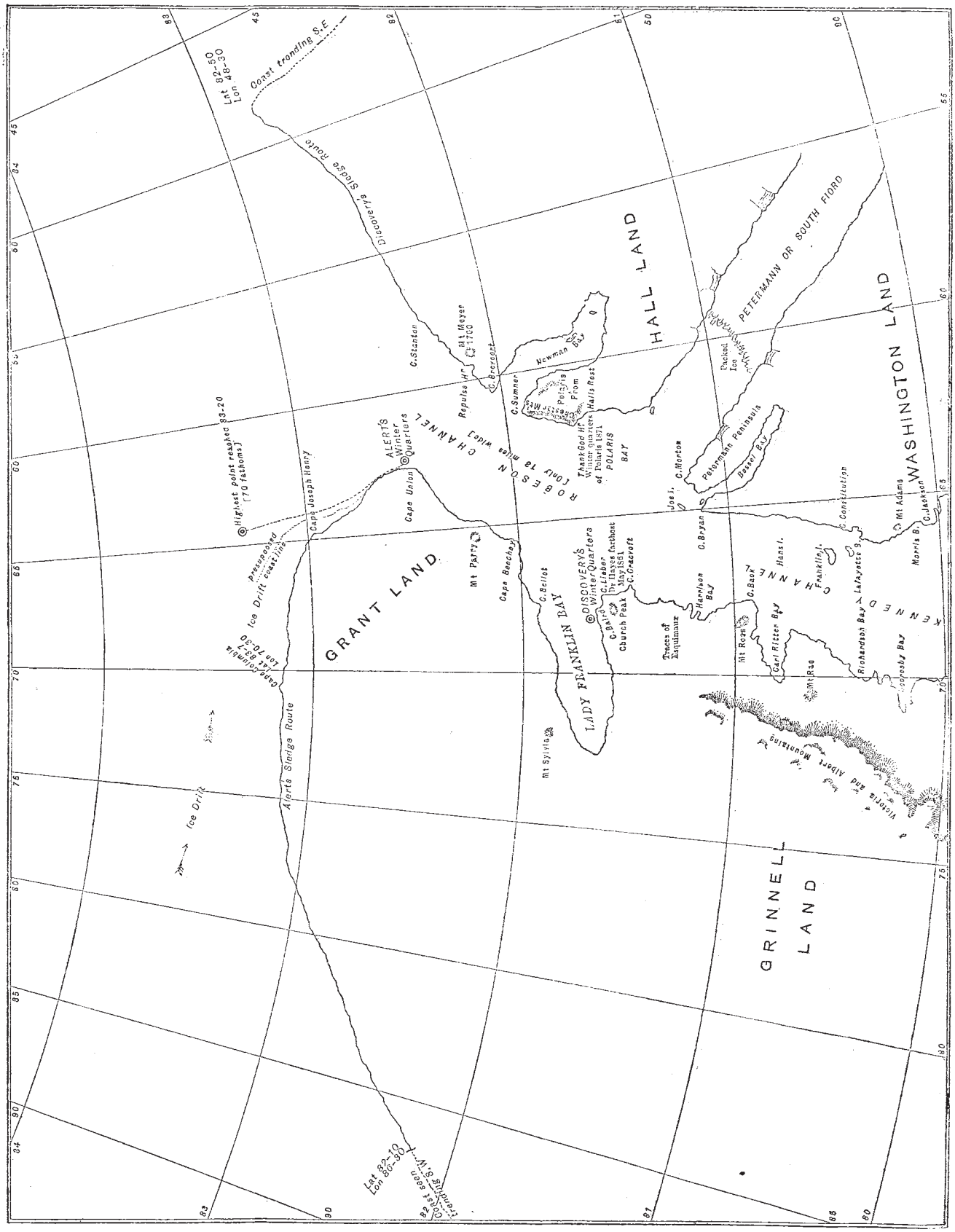
Similar instruments are employed for determining the velocity of projectiles, but in these the cylinder travels at a much higher velocity, and other means of controlling it are made use of.

THE ARCTIC EXPEDITION

IT will of course be some time ere all the results obtained by the Expedition which has just returned from its year's sojourn on the edge of the ice-blocked Polar Sea can be presented to the public. Enough, however, is known to lead us to believe that abundant additions of the highest importance to our knowledge of the physics and natural history of the Arctic Regions have been made; and meantime we are able to exhibit in a map the main additions which have been made to Arctic geography.

The *Alert* and *Discovery*, under Captains Nares and Stephenson, left England in May, 1875. Godhavn was left on July 15, and all seems to have gone well till July 30, when, after leaving Port Foulke, the ice was met off Cape Sabine, 78° 41′ N., from which point the ships had a constant struggle with the pack to the north end of Robeson Channel. So close was the ice that on every occasion the water channel by which the ships advanced very soon closed behind them, rendering it as difficult to return as to proceed north. On August 25, after many hairbreadth escapes, a well-sheltered harbour was reached on the west side of Hall's Basin, north of Lady Franklin Sound, in lat. 81° 44′ N. Here the *Discovery* was secured for the winter, a few miles north of Polaris Bay, which was in sight on the opposite side of the channel.

The *Alert*, pushing onward, rounded the north-east point of "Grant Land," but instead of finding a continuous coast-line leading 100 miles further towards the north, as everyone had expected, found herself on the border of what was evidently a very extensive sea, with



Map showing Discoveries of Arctic Expedition.

impenetrable ice on every side. No harbour being obtainable, the ship was secured as far north as possible, inside a sheltering barrier of grounded ice, close to the land, and there she passed the winter; during her stay of eleven months no navigable channel of water permitting further advance to the northward ever presented itself. We believe that had an accident not happened to the screw of the *Alert* she would have endeavoured to push still further north; but the current round the corner of the land was so great she could not make headway. It was fortunate that the accident happened, for had she gone much further she would probably have got so jammed in the frightful ice-masses that it would have been impossible to get her out again. In lieu of finding an "open Polar sea," the ice was of most unusual age and thickness, resembling in a marked degree, both in appearance and formation, low floating icebergs rather than ordinary salt-water ice. It has now been termed the "Sea of Ancient Ice"—the Palæocrystic Sea; and a stranded mass of ice broken away from an ice-floe has been named a floe-berg. Whereas ordinary ice is usually from 2 feet to 10 feet in thickness, that in the Polar Sea, in consequence of having so few outlets by which to escape to the southward in any appreciable quantity, gradually increases in age and thickness until it measures from 80 feet to 120 feet, floating with its surface at the lowest part 15 feet above the water-line. In some places the ice is spoken of as reaching a thickness of from 150 to 200 feet, and the general impression among the officers of the expedition seems to have been that the ice of this "Palæocrystic Sea" is the accumulation of many years, if not of centuries, that the sea is never free of it and never open, and that progress to the Pole through it or over it is impossible with our present resources. It is interesting to note that the Aurora Borealis was not distinct in these latitudes, the latitude being supposed to be too high; this is consistent with the observations of the *Polaris* expedition, Dr. Bessels rarely finding the colours brilliant enough to give a spectrum.

When it was seen that further advance with the ships was impossible, all the energies of officers and men were directed to sledge-work. Sledge-parties were sent out northward, eastward, and westward, depôts having been established at intervals in the two former directions last autumn ready for the parties to be sent out during the spring of this year.

Although the two ships were only seventy miles from each other, it was impossible for any communication to pass between them till last March, when a party from the *Alert* succeeded in reaching the *Discovery* and relieving those on board the latter of any doubt as to the fate of their fellows. Owing to the high latitude of both ships the winter was unusually long and dark, the sun having been absent 142 days, and the cold was more intense than had ever been experienced by any previous expedition. All the old and a few new expedients were resorted to to relieve the unimaginable monotony of such a position, and apparently with great success. The lowest temperature observed was 104° below freezing, Fahr., at least 20° below the minimum observed by the *Polaris* expedition, and the mean temperature for thirteen consecutive days was 91° of frost; the mercury was frozen forty-seven days during the winter.

As soon as the sun appeared in the spring of this year active preparations were made for sledge-exploration, and by the beginning of April each ship was left with only half-a-dozen officers and men whose duties kept them on board. After that date sledges were continually arriving and departing, carrying forward provisions to be placed in depôt, ready for the return of the advanced parties.

Capt. Stephenson, besides looking after his own division, visited the *Alert*, and also made two trips across Hall's Basin to Greenland, and Capt. Nares started off like the rest, with Capt. Feilden, naturalist to the Expedition, immediately all the provision depôts were complete along the line of route, and the safety of the travellers insured. When at Polaris Bay Capt. Stephenson hoisted the American ensign and fired a salute as a brass tablet, which he and Capt. Nares had prepared in England, was fixed on Hall's grave. The plate bore the following inscription:—"Sacred to the memory of Captain C. F. Hall, of the U.S. ship *Polaris*, who sacrificed his life in the advancement of science on November 8, 1871. This tablet has been erected by the British Polar Expedition of 1875, who, following in his footsteps, have profited by his experience."

A party, headed by Commander Markham and Lieut. Parr, made a most gallant and determined attempt to push northwards by means of sledges. They were absent 72 days from the ship; and on May 12 succeeded in planting the British flag in lat. 83° 20′ 26″ N., within about 400 miles of the Pole. From this position there was no appearance of land to the northward, but, curiously enough, the depth of water was found to be only 70 fathoms. Owing to the extraordinary nature of the pressed-up ice, a roadway had to be formed by pickaxes for nearly half the distance travelled before any advance could be safely made, even with light loads; this rendered it always necessary to drag the sledge loads forward by instalments, and therefore to journey over the same road several times. The advance was consequently very slow, and only averaged about 1½ mile daily—in fact, much the same rate attained by Sir Edward Parry in his somewhat similar attempt during the summer of 1827. Although the distance made good was only seventy-three miles from the ship, 276 miles were travelled over to accomplish it. It is quite impossible for any body of men ever to excel the praiseworthy perseverance displayed by this gallant party in their arduous struggle over the roughest and most monotonous road imaginable. Their journey, considering the ever-recurring difficulties, has eclipsed all former ones.

The result of their severe labour is held to prove the impracticability of travelling over the Polar Sea to any great distance from land, and also that Baron von Wrangell was perfectly correct in his expressed opinion that before the North Pole can be reached it is first necessary to discover a continuous coast line leading towards it.

In addition to the despatch of the northern travellers, the coast line to the westward of the *Alert's* position was traced for a distance of 220 miles by a party under the command of Lieut. Aldrich; the extreme position reached was in lat. 82° 10′ N., long. 86° 30′ W., the coast line being continuous from the *Alert's* winter quarters. The most northern land, Cape Columbia, is in lat. 83° 7′ N., long. 70° 30′ W. The coast of Greenland was explored by travelling parties from the *Discovery*, under the command of Lieutenants Beaumont and Rawson; they succeeded in reaching a position in lat. 82° 18′ N., long. 50° 40′ W., seventy miles north-east of Repulse Harbour. The land extended as far as lat. 82° 54′ N., long. 48° 33′ W., but very misty weather prevented its character being determined with exactness. The coast is much cut up into fjords and land was seen to the north-east, probably reaching to 83°. Lieut. Archer, with a party from the *Discovery*, explored Lady Franklin Sound, proving that it terminates at a distance of sixty-five miles from the mouth, with lofty mountains and glacier-filled valleys to the westward. Lieut. Fulford and Dr. Coppinger explored Petermann Fjord, finding it blocked up with a low glacier, which extends across from shore to shore. With the exception of Hayes Sound the coast line of Smith Sound has now been explored from north to south. President Land, marked in recent maps in about 84° N., is proved to have no existence, though Lieut. Aldrich, when engaged in pioneering the way for the main party, which was led by Commander Markham, advanced three miles beyond Sir Edward Parry's most northern position,

and, from a mountain 2,000 feet high, sighted land towards the west-north-west, extending to lat. 83° 7′.

Ancient Eskimo remains were traced on the west side of Smith Sound up to lat. 81° 52′ N. From that position the wanderers had evidently crossed the channel at its narrowest part to Greenland. The most diligent search was made further north, but no trace of them discovered.

Six musk oxen were shot at the *Alert's* winter quarters, and three half way between her position and that of the *Discovery*, while fifty-four were shot near Discovery Bay. The ermine was seen, and owls were found on the Greenland shore opposite the *Discovery's* quarters, the young ones on their appearance being mostly devoured by wolves. The remaining items in the *Alert's* game list at her northern station show seven hares and ninety birds of different kinds, the latter shot only in July. The birds certainly do not migrate beyond Cape Joseph Henry, lat. 82° 50′ N. Very few besides those accounted for by the sportsmen passed the *Alert*. Very few seals were seen north of Cape Union, and no bears, dovekies, or looms, it is stated, ever reach the Polar Sea. Water animals were notably absent, and it is surmised that those that do visit the Arctic Sea come from the south. Among other birds visiting the country, but not advancing beyond the point mentioned, are the knots. Although no nests or eggs were found, the young in all stages of growth were obtained. Amongst the flora described by the parties from the *Alert*, were the saxifrage, sorrel, and dwarf oak, and late in the summer a few poppies were met with.

In the neighbourhood of the *Discovery's* winter quarters a seam of coal of good quality and readily worked, was discovered by Mr. Hart, naturalist; but, unfortunately, not before the present summer, otherwise it might have been of service during the winter, when the allowance of that article on board was necessarily kept as low as possible. Capt. Feilden obtained some fine fossil corals at the extreme northern hills. Very large collections of natural history subjects have been made by the naturalists, assisted by one and all of the officers and crew. The dredge and trawl were used on several occasions with great success. The observations on the physics and meteorology of the Arctic Regions are likely to prove of the greatest value when published. It will be remembered that during the stay of the *Polaris* in the north, the prevailing wind was from the north-east; during the present expedition scarcely any easterly wind was noticed at all, the prevailing wind, like the prevailing current, coming from the west.

All the *Polaris's* cairns were visited. At the boat depôt in Newman's Bay a box chronometer by Negus, New York, was found to be in perfect order after an exposure of four winters; it has since been keeping excellent time on board of the *Discovery*. Some wheat sent out in the *Polaris* in order to ascertain whether it would deteriorate when exposed to extreme cold, has been grown successfully under a glass shade by Dr. Belgrave Ninnis.

A magnificent series of photographs has been brought home, a selection of which will no doubt be published, and afford some idea of the strange scenery to be seen in these inhospitable regions.

Such is a brief summary of the results obtained by this latest Arctic expedition, but at what expense of hard work and suffering it is difficult for those who read the narrative to realise. The labour which had to be undergone would have been trying enough to perfectly healthy men, but unfortunately the dreaded scourge of Arctic explorers, scurvy, broke out among them. No expedition could have been better provisioned, but in spite of every precaution all the sledge parties suffered most severely. Notwithstanding this, every one worked determinedly and cheerfully. Only three seamen, however, died of scurvy, and only one death was the result of frostbite, that of Niels Christian Petersen, the interpreter of the expedition.

The ice in the Polar Sea remained firm until July 20, when there was a movement, increasing with each tide. On the 31st the *Alert* succeeded in leaving her winter quarters, and, after many struggles with the ice, joined company with the *Discovery* on August 12. Lady Franklin Bay remained closed until the 20th, when, a chance occurring, both ships were pushed into the ice, and succeeded in crossing. After this date the same kind of battle and slow progress took place daily between the ships and the ice, as during the passage north every inch gained being of importance as the ice closed in the rear. As the season advanced, or rather slipped away, many were the fluctuations in the social barometers as hopes and fears rose and fell, for it was not until September 9, the very last of the season, that the mouth of Hayes Sound was crossed, and the expedition again rejoiced in "open water."

The *Alert* reached Valentia on the 27th ult., and both ships arrived at Queenstown on the 29th. On Monday they left for Portsmouth, where they arrived on Wednesday morning. "It goes without saying" that everywhere officers and men have had the heartiest welcome, though no heartier than they deserve.

OUR ASTRONOMICAL COLUMN

μ DORADÛS.—This star, which was called a fifth magnitude by Lacaille at the end of 1751, and a sixth by Brisbane, was observed by Moesta from February, 1860, to January, 1861, of 8·9m. or 9m. only. Perhaps one of our southern readers will put upon record the actual magnitude of this star, the period of which, as Moesta remarked, would appear to be one of considerable length. Position for 1877·0 in R.A. 5h. 5m. 52s., N.P.D., 151° 58′.

SOUTHERN DOUBLE-STARS.—(1) α Centauri.—Measures of the angle of position and distance of this star, taken in the course of the ensuing year or two, will materially contribute towards defining within narrow limits the elements of the orbit. Even in Powell's last orbit, which was founded upon measures to January, 1870, the peri-astron passage (1874·2) is certainly too early, though each successive calculation of elements from Jacob's first has assigned a later date; it probably occurred in 1875.

(2) p Eridani also deserves close attention from the astrometer in the other hemisphere. There must be a great change in angle since the epoch of the last-published measures. The position (1877·0) is in R.A. 1h. 35m. 7s., N.P.D. 146° 49′.

THE INTRA-MERCURIAL PLANET QUESTION.—If in the general formula obtained by M. Leverrier, and given in last week's NATURE, we put $k = -1$, the solution, which gives for the sidereal period as referred to the node 27·964 days semi-axis major 0·180, and synodical period 30·282 days, accords with Stark's observation on October 9, 1819, one of the most definite upon record, besides representing, as well as the solution with $k = 0$, the five data upon which M. Leverrier has relied in deducing the formula. In this case we have—

$$v = 285°·76 + 12°·873724j - 10°·8 \cos v.$$

Stark's observation was published in his "Meteorologisches Jahrbuch," 1820. Under date, October 9, 1819, he says:—"At the same time there appeared, at a distance of 12′ 28″ from the southern limb of the sun, and 4′ 58″ from the eastern limb, a black, well-defined nuclear spot, which was perfectly round and of the size of Mercury. At 4h. 37m. this nuclear spot was no longer present, and I found also later on the 9th, as well as on the 12th, when the sun next came out, no trace of this spot." The observation was probably made about noon at Augsburg, which was one of Stark's usual hours for examining the sun's disk—corresponding to October 8, at 23h. 16m. Greenwich time. For this time the above formula gives $v = 16°·9$,